DOCUMENT RESUME

ED 265 873 IR 051 416

AUTHOR Estes, Nolan; Klier, Betje
TITLE An International Study of the Impact of New Information Technologies on Curriculum and Institutional Structures.
PUB DATE 85
NOTE 46p.; Paper presented at the Annual Meeting of the American Educational Research Association (Chicago, IL, March 31-April 4, 1985).
PUB TYPE Viewpoints (120) -- Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Case Studies; *Curriculum Development; Developed Nations; Educational Technology; Foreign Countries; Higher Education; *Information Science; *Instructional Development; International Organizations; National Surveys; Public Schools; School Districts; *Teacher Education; *Technological Advancement; *Technology Transfer
IDENTIFIERS Organisation for Economic Cooperation Development

ABSTRACT

Designed to provide information on how educational institutions and government agencies are implementing new information technologies (NITs), this report combines an in-depth case study of 25 U.S. educational institutions (school districts, colleges, and universities) with an international study of exemplary educational programs in nine countries. Aspects addressed in the study include the role of the NITs in the instructional program, in policy structure, in management support services, and in teacher training and teaching functions. Information for the U.S. study was gathered through a lengthy questionnaire and comprehensive telephone and/or site visit interviews. Subsequent to the U.S. study, a similar study analyzed trends in curricula and institutional structures in Australia, Belgium, Canada, Denmark, Japan, New Zealand, the Netherlands, Turkey, and the United Kingdom. Concluding that the impact of the NITs on education has been powerful but is as yet inchoate and undefinable, the paper concludes with a discussion of the implications of the changes observed for future use of these technologies in education and some recommendations for research. (THC)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
OERI
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
[X] This document has been reproduced as received from the person or organization originating it.
[ ] Minor changes have been made to improve reproduction quality.
• Points of view or opinions stated in this document do not necessarily represent official position or policy.

An International Study of the Impact of New Information Technologies on Curriculum and Institutional Structures

by Dr. Nolan Estes and Dr. Betje Klier
The University of Texas at Austin
Consultants to the Organization for Economic Cooperation and Development

ED265873

INTRODUCTION

THE ROLE AND FUNCTION OF THE OECD

At their international conference in Paris last July, OECD delegates, observers, and experts from 24 member countries focused on one of the most important issues facing educators--the impact of the pervasive use of the New Information Technology on the schools in Western society. The Center of Education Research and Innovation (CERI), a Committee of the Organization for Economic Cooperation and Development (OECD), sponsored this gathering.

The OECD is a multi-national organization which developed as an outgrowth of the Organization for European Economic Cooperation (OEEC), the coordinating unit for United States aid to rebuild war-torn and economically ravaged Europe through the Marshall Plan. Common interests led the United States and many other nations to formalize their mutual concerns in 1960 when the original 20 nations signed the Convention of the Organization for Economic Cooperation and Development.

IR051416

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Nolan Estes
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Although the work of the United Nations (the U.N.) and the North Atlantic Treaty Organization (NATO) had higher visibility in the immediate post World War II world, the OECD began its task of promoting the economic growth of its member countries by facilitating the expansion of trade among the more and less developed countries both inside and outside its membership.

The OECD produced a generally impressive record of documentation, communication, and cooperative activity in the economic sphere with the United States a principal partner in these activities. Proceeding with greater unity and less political confrontation than UNESCO (United Nations Education, Social and Cultural Organization), two education committees have been almost overlooked in the concentration on trade and other economic activities. Two OECD committees designed to assist member countries in areas of common concern in the field of education, the Education Committee and the conference sponsor, the Centre for Educational Research and Innovation (CERI), have quietly conducted an on-going comparative review of educational structures and planning issues which includes the collection and dissemination of statistics and other indicators of educational trends. The Education Committee has tended to concentrate on issues of interest primarily to government education officials who come as representatives to OECD meetings at its headquarters in Paris. On the other hand, CERI tends to examine new options

in education of special interest to university researchers and other experts. Both interest groups responded to this project.

Concerned with the dramatic impact of the New Information Technologies in the economic sector, CERI members in 1981 sought approval from the CERI Governing Board of a major study of a similar potential impact of modern information technology on education. During the first phase of the study from 1982 through 1984, CERI project activities and meetings focused on the collection and analysis of data concerning policies, practices and research on the introduction and use of the New Information Technologies in education in various countries.

The conclusion of this phase came with the July 1984 conference in Paris. Government officials, university researchers, and other experts gathered to discuss the issues raised by the study activities and to develop recommendations for follow-up activities.

Surveys, case studies and syntheses of findings exceeded 500 pages of documentation including a synthesis of the main issues, prepared by the OECD secretariat. Based on all other completed work, the synthesis suggested the following conclusions:

First, the new technologies, in addition to their role as support tools for teachers or as a new subject for the school curriculum, have the potential to change radically the structure and organization of education, as well as its productivity and

delivery mechanisms. Second, the response of educational systems to this potential would to a considerable extent be influenced by factors outside educational systems since these technologies are having a pervasive impact on all of society and the economic structures. The responsiveness and adaptability of educational systems to this unanticipated technological revolution would determine their credibility and legitimacy as social institutions. Member countries strongly desire information on the effective use of technology in the schools having identified the current shortage of educational computer software as a barrier to using computers in the schools to improve instruction. The United States, Canada, and the United Kingdom are the most advanced in their explorations. All are anxious to avoid duplication of efforts. Delegates showed widespread interest in various means that could be implemented by OECD to improve knowledge of existing software, their educational use and effectiveness, and to reduce the legal and technical barriers that inhibit the transportability of software products across national boundaries. The OECD, with its translation and dissemination structure, seems a suitable instrument for the collection and exchange of information among member countries.

We hope that the OECD will continue to facilitate the exchange among nations of information which will enhance education--a goal shared by all.

CASE STUDIES: NATIONAL AND INTERNATIONAL

Description of the Study.

This document summarizes an in-depth USA study and a nine nation survey, two of the case studies among the documentation from which these synthesis statements were derived.

An in-depth case study analyses the impact of technology on education in 25 USA educational institutions, including both public school districts, colleges, and universities. Information was gathered through the use of a lengthy questionnaire and a comprehensive telephone and/or site visit interview. Aspects of the study include the role of technology in the instructional program, in policy structure, in management support services, and in teacher training and teaching functions. The study institutions provide a framework for categorizing and for gaging current and future technological trends in education in the USA.

Subsequent to the extensive USA Study, a similar study analyzed the trends concerning changes in curricula and institutional structures in Australia, Belgium, Canada, Denmark, Japan, New Zealand, the Netherlands, Turkey, United Kingdom and the United States. In contrast to the large number of responding USA institutions, the case studies of these nine countries tend to be exemplary or noteworthy rather than typical. In a scaled-down questionnaire in late 1983, respondents depicted

changes in curricula, in teaching-learning environment, and in institutional structures.

The purpose of both studies is not to make judgments about the utility of the new information technologies nor to propose changes, but rather to provide information on how government agencies and educational institutions are implementing the technology. The study, funded by the Organization for Economic Cooperation and Development in Paris, was designed solely to gather information regarding the role and impact of technology on education.

Computer companies continue to manufacture and sell equipment to schools, often faster than the educators can adjust. With heavy community and national pressure to place the new information technologies in the classroom, few at the local level are clear about the best way to proceed.

What is clear, however, is that the new information technologies are not just another passing educational fad. Unlike the programmed instruction of the 1960's or similar failed trends, the new information technologies have permeated all walks of life. Using technology in schools is not just a new way to teach concepts. It is an essential part of training our students to be prepared for life after school.

This clarity begins to fade, though, as questions emerge about defining the appropriate function of technology in schools, stipulating the content and process of teaching with or

about computers, identifying jobs for which to train students, planning for the future in such a fast-changing field, assuring equal access to the benefits of the new technology, and managing and financing the privilege of using the technology.

TWO CASE STUDIES

Methods

This report utilizes a multiple case study analysis approach. The information was obtained from the participating institutions in a variety of ways. A detailed questionnaire was sent to each institution, followed up by a lengthy telephone interview (averaging 90 minutes each) and/or a site visit interview (averaging several hours) with appropriate staff member(s). Each interview was guided by the structured questionnaire and sought to clarify the points in the questionnaire.

After each interview, the study consultant who conducted the interview developed a detailed written description of the institution's technology program, following a standard format. At the completion of all case studies, the consultants worked, both individually and as a group, to analyze trends and policies that could be generalized across the studies as well as strategies that were unique to individual institutions. The final report consists of a summary of trends and changes in curricula, in the teaching/learning environment and in institutional structures.

Data Source

The institutions selected to participate in the study were chosen from a group known to be in the forefront of implementing technology programs. This strategy was employed in order to gather the greatest amount of information for educators who are in planning stages and seeking information about approaches that have already been undertaken by others. A total of 40 institutions were originally contacted to participate in the study. Of these, the 25 public and private institutions included in the final report are geographically spread across the US and span the size continuum. (The others were excluded due either to lack of cooperation or insufficient information for a complete case study.)

The method for the separate world study was also a multiple case study, however, the study is limited to the nine countries which returned their written questionnaire. Because of geographic distribution, no interviews were conducted. Beyond consideration of changes in curricula and institutional structures, the content of the remainder of the survey diverges. Whereas the USA study considers management support services plus teacher training and teaching functions, the world study considers changes in the teaching-learning environment.
in higher education. The computer as a delivery mechanism had not had general impact in various curricular areas.

CHANGES IN THE CURRICULUM

The international study of curricular changes does not present trends of redesigned curriculum. Instead the study depicts involvement in self-assessment, modifications of existing curriculum, and heightened interest in the experiences of others. Perhaps it is too early to be certain as to how the introduction of new technology is affecting the curriculum. Although we are just able to draw indications as to possible future developments, some of the teachers questioned whether anything new was being done with the computer that had not been done before, albeit in other ways. This attitude emerges as technology is considered in delivering or implementing the curriculum but might be a denial on the part of some of the power of technology.

The dearth of software is continually cited as a restriction to implementation of curricular changes in many studies regardless of the subject under consideration. Additionally, the United Kingdom study cites the lack of good software as a major limitation in the application of technology to education and point out that this shortage of software can lead to the undesirable effect of curricular distortion. Activities are undertaken that fit the availability of particular software rather than meeting goals.

Rather than typical applications or identifiable trends, exemplary programs are cited:

Values clarification is a part of the computer literacy program in Denmark where all students in grades 5-9 study the positive and negative societal implications of the new technology as well as programming and information about the hardware.

-- In the United Kingdom study, the computer has provided the students a method for handling primary source data, which would not otherwise have been possible.

-- The Australian study illustrates the successful application of computer-assisted instruction to the area of handwriting. The procedure for teaching handwriting skills has been radically changed as a result of the introduction of the technological approach. Since the technology is used to present exercises, the teachers have spent a greater proportion of the time in reviewing curriculum materials and deciding which materials suit individual students. In essence, the repetitive aspects involved in the traditional forms of teaching handwriting have been replaced by a computer presentation which offers significant advantages. It was found that changes in curriculum had taken place in this instance because teachers have started to use the technology as a classroom research tool. They have begun to experiment with varying curriculum materials for different students. Thus, the technology has given teachers a

powerful tool with which to plan appropriate curriculum strategies.

Public School Settings

Public school districts have generally modified their instructional programs to incorporate the use of technology in three ways: (1) teaching with computers (computer-assisted instruction), (2) teaching about computers (computer literacy, computer science, programming), and (3) using computers to record students' progress through the instructional program (computer-managed instruction). The case studies indicate wide variations in the extent to which districts use computers for these purposes, as well as in the level of student and subject matter targeted. However, some generalizations are possible:

-- The primary use of computers at the elementary level is for computer-assisted instruction (CAI) in math and reading.

-- Computer literacy courses are generally introduced at the junior high level (7th and 8th grades) and then continued at senior high.

-- The impact of technology at senior high is most evident in the addition of new courses in the areas of math, science, and vocational education.

-- The most frequently reported use of CAI is for drill and practice, followed by its use for enrichment and

remediation. Very minimal use is reported for problem-solving, simulation, or the development of reasoning skills.

-- The students with greatest access to the computer are those at the two ends of the continuum: the gifted/talented at one end, and the slow, disadvantaged, or special education student at the other end.

-- Overall, the new information technologies have had only a moderate impact on the elementary and middle school curricula. Most elementary curricula have remained unchanged, with teachers using the computer as another teaching tool to support or supplement the regular program of instruction. Computer literacy courses may be introduced at the middle school level, but not in any interdisciplinary fashion.

The impact of technology on upper secondary curricula is most evident in the addition of computer science courses and other computer-related courses in mathematics, science, and vocational education (e.g., job training courses).

-- The survey conducted by the US Council of Great City Schools indicates that all the large districts but one offer computer science courses, averaging about seven different such courses per district. In general, these course offerings focus on programming skills or computer theory.

-- One of the New Zealand case studies describes a secondary school which has implemented computer studies courses as an optional subject over a three-year sequence. A variety of topics are included, which are presented at more advanced levels of understanding each successive year.

-- One of the Dutch case studies describes a school for general secondary education in which computers are used for a computer science course, a test service system, and remedial teaching.

-- The Belgian study describes the use of computers in three secondary technical schools for teaching vocational training in the areas of accountancy and bookkeeping.

-- In the United Kingdom case study of secondary education, computing studies courses are offered in which students learn at least three different computer languages and work in close contact with local businesses on real projects. In addition, a special course on Micro-computer Applications is offered.

-- The vast majority of the districts described in the United States study have added new computer-related courses at the secondary level. Many districts reported much greater impact on the secondary curricula than on the elementary level.

The impact of technology at the secondary level is most evident in the addition of new courses, less evident in the modification of existing courses, and minimally evident in terms of interdisciplinary involvement.

-- The United States study indicates that the only modification of existing courses has occurred in the areas of mathematics, science, and vocational education. Other subject areas are relatively untouched by the new information technologies.

-- An exception is reported in a New Zealand case study in which the introduction of microcomputers has caused an increased awareness among the staff and students about some of the social implications of the new technology. As a result, a 12-hour module on "computer awareness" has been added to the Social Studies curriculum.

-- Another notable exception is described in the United Kingdom case study on secondary education. Computer awareness has been introduced as an essential element in each of the major subject areas of the core curriculum (mathematics, science, European studies/English, and humanities). In addition, the use of information technology has been gradually developed in science for simulation and data capture, in technology for design and drafting, in music for practice and self-correction in the learning of chords and intervals, in English for

the development linguistics and logical problem-solving, and in remedial courses for children with learning difficulties.

-- The vocational training programme described in the Belgian study implies some interdisciplinary involvement in that other subjects such as business law, economics, and management have been integrated with the use of technology.

Colleges/Universities

Instructional Program: In most of the institutions of higher education, only select departments have felt the impact of the new technology: departments of education, math, science, and engineering. In the departments of education, student teachers are being exposed to the hardware and software representative of school classrooms. In the other departments, new courses related to technology have been added.

Colleges and universities vary greatly in the extent to which new information technologies have effected changes in the curricula. However, all of the institutions of higher education included in the various case studies report some change. Information technology subjects such as control technology already feature in the curriculum particularly in technical and vocational education. These may be accompanied by a reappraisal of the relationship between content and process as it relates to

the need of providing young people with the necessary skills to cope with rapid social and technological change. In this context the introduction of information technology can be seen to be part of a more general debate about the purpose of education and the balance between the needs of the individual and those of society.

Changes are likely to take place in the existing patterns of organization in education in order to realize the full potential of information technology. In some cases this may demand the creation of new structures. This may happen relatively easily in the vocational and training sectors where outcomes are more readily measured. Here the introduction of information technology may demonstrate cost advantages and/or allow training to take place in more flexible circumstances.

-- At the low end in the United States study, computer awareness or literacy courses are an available option to all students, and application courses have been added in the departments of mathematics, science, and business.

-- At the high end in the United States study, all departments in the institution have integrated the use of technology into their degree programs.

-- The extent to which new information technologies have caused change in the United States higher education curricula is largely a function of the overall focus of

the institution: the more technical schools indicate higher impact than do liberal arts schools.

-- Differences in the amount of curricular change are also attributable to the fact that the United States technology instructional programmes surveyed are in various stages of development--some in the first one or two years of implementing the use of technology for instruction while others have been abreast of technological progress for 15 years.

-- In a New Zealand case study, faculty reports structural and/or content changes as a result of NITs in just over half of the 66 courses surveyed.

-- In the United Kingdom study of further education, new techniques and systems have had an effect on the content throughout the range of courses offered. This is largely attributable to the fact that training in the use of technology is the "raison d'etre" for the college surveyed. Throughout every area of the college there is a concern for real applications as well as theoretical understanding.

Impact on Pre-service and In-service Teachers

Teachers in the computer-related subject areas have learned new skills and modified their curriculum methodology accordingly.

-- Some of the districts in the United States study indicate that the teachers are forced to learn the new skills when they are mandated to teach new courses.

Training of pre-service teachers is an area of moderate impact in terms of curricular changes in higher education as a result of NITs.

Summary of Findings

With regard to management support services, the USA survey finds that most of the respondent districts and universities had been using technology for management support services for longer than they have used it in instruction. Furthermore, greater consensus emerges as to the need and purpose of technology for management services than for instructional uses.

A wide variety of strategies are reported in the approach to teacher training ranging from two-hour form two-hour workshops to full certification programs, and from voluntary programs to training required for all teachers in a district. Generally, teaching functions have not changed, except that some teachers are designated to teach new courses or to train others in technology.

At the college or university level, the approach to teacher training is far more haphazard than in public schools and reflects the high degree of autonomy typical of faculty members in higher education.

-- Generally, United States teacher education courses utilize hardware and software that is representative of what is currently used in elementary and secondary schools. This is usually integrated into standard "methods" courses.

-- Several United States institutions offer new degrees that focus specifically on the application of technology to education, for example, a Master's degree in Instructional Technology.

-- Overall, the structure, content, and methodology of the Untied States education pre-service training courses have not been impacted to a substantial degree. The US Congress Office of Technology Assessment Reports that teacher training colleges in the United States are providing adequate instruction to new teachers in the use of information technology.

Technology-related training of in-service teachers is largely being conducted by the school districts that employ them.

-- Most United States districts have an ongoing professional growth programme for their teachers, to which new courses related to technology have been added. These programmes typically are optional, are scheduled after school hours, and offer in-service credit to the teachers toward increased tenure or pay scale level. In

some districts, this represents the entire teacher training programme in the technology effort; in other districts, this format is provided in addition to some more centrally-administered programme. The districts with this option report heavy teacher participation and interest for technology-related courses.

-- Several Untied States districts are mandating all teachers to participate in a centrally-administered training programme. In some cases, this learning is conducted during one school year. In other cases, the training is phased in over several years, usually starting with the teachers who will teach with computers first.

-- Some United States districts are providing training only for selected personnel, who are then expected to conduct training and/or act as a resource person at their local school. This responsibility is usually added to the staff person's regular duties (as teacher, librarian, assistant principal) with no additional salary.

-- A few United States districts have a decentralized training system, in which each school develops and implements its own training programme in line with the needs of the individual school. In some of these cases, the district will not approve a school's request to

purchase computer equipment until adequate provision has been made for teacher training at that school.

-- The content covered in the United States training programmes ranges from programming and word processing skills to information about hardware, software, technical vocabulary, implementation strategies, operations, and classroom applications. Only a few districts focus on the broader aspects of technology and society, the future of technology, or the interdisciplinary integration of technology into the curriculum.

Distance and Further Education

The impact of curricular changes on distance education appears to be greatest in the area of higher and further education, and much less at the primary and secondary levels of education.

-- The United States study reports that several school districts utilize instructional television, cable television, closed circuit television, and/or radio to supplement the regular programme of primary and secondary instruction. However, except in a few rare cases, these distance strategies are not extensively used for instructional purposes.

-- The US Council of the Great City Schools reports that the majority of city schools now have, or plan to have,

cable capacity. In addition, about half of these districts use electronic mail, several have or expect to have video-disc, and a few are experimenting with robotics. Some districts operate their own television or radio stations. Again, these distance strategies are in initial stages of implementation for instruction.

-- For several years some city colleges in the United States have offered degree programmes through local television stations, with examinations taken at one central location. Often such programmes are targeted at people who work full-time, are restricted by handicaps, or are isolated in settings such as prisons. These programmes are not documented in the case studies, but are generally known. They typically consist of videotapes of on-campus lectures, with no capability of interaction between student and teacher.

-- A case study from Turkey reports the use of a video system for in-service training of teachers of hearing impaired children.

-- A case study from an Australian university reports several uses of distance education: (1) on-line access to the library catalogue; (2) regular communication links for electronic mail, electronic course material, data files, assignments, and assessments; (3) teleconferencing by telephone to allow group discussions among

staff and students; (4) teleconferencing via satellite between staff and distance students; and (5) special support services with modified tape recorders for disabled people.

-- A case study from British Columbia reports on distance education through the use of telecommunications networks as a joint venture of government, universities, community colleges, and provincial institutes.

Although institutions involved in distance education initially expected no changes in the curricula as a result of the NITs, changes have in fact been noted.

-- The Australian university case study describes initial efforts to use the same teaching staff, the same syllabus, and the same examinations for the on- and off-campus students. More recently, the validity of this model is being questioned given the technological changes that have occurred.

They see the integrated model as making a virtue out of necessity as well as having inherent educational merit. It is becoming increasingly clear that the integrated model supports a fragmented system of distance education in which there are too many providers.

-- The British Columbia case study indicates that, despite expectations to the contrary, certain changes do take place when courses are taken from the classroom setting

and adapted for distance delivery. The content itself remains relatively unchanged, but the distance education product is improved, being better planned, organized, structured, and presented than the average lesson delivered to a regular classroom. Distance education courses also tend to be more varied and stimulating, because a multi-media approach is chosen over the traditional "chalk and talk" in the classroom. On the other hand, the distance education product is also less spontaneous, relaxed, and informal than the traditional classroom presentation.

-- The British Columbia case study speculates that the distance education medium must inherently require cognitive shifts in the information-processing skills used by the distance students, but that such changes are invisible, intangible, and difficult to articulate.

-- The Turkish case study reports that the curriculum became more flexible and changeable with the advent of video-aided teaching.

CHANGES IN THE TEACHING/LEARNING ENVIRONMENT

Individualization of Instruction

Data specifically relates to the impact of technology on individualization of instruction and on attitudes of educators, plus the physical changes brought on by technology. Because of the restricted scope of the international case studies, it is difficult to estimate the actual numbers of students and teachers who utilize computers on an ongoing basis. However, the limited evidence available indicates that these numbers are generally relatively small. General trends are not definable.

The new information technologies have definitely increased individualization of instruction, but only for special populations of students such as special ed or gifted curriculum in the US. The international survey brought forth additional examples of special programs for the handicapped. The Commission of the European Communities reports the use of computers for teaching a wide range of handicapped students, from those with cerebral palsy, autism, or sever motor impairment to those who are blind, deaf, or non-lingual.

As an example of an atypical but exemplary use of technology, the Australian handwriting program was originally developed for mildly intellectually handicapped pupils. Equipment to suit the given learning task was devised and adapted although

the educational objectives were not compromised to suit readily available equipment.

On the other hand, in non-compensatory education, little individualization of instruction has been promoted by the use of technology at the secondary level. Occasional mention is made of the goal of individualization, if not the results.

-- The Belgian case study does report an increase in individualization in that each group of three students creates a simulated business enterprise related to those students' progress. (It is unclear, however, how the use of technology enhances this, since similar activities could be conducted on paper.)

-- A New Zealand case study specifically points out the need for good quality and inexpensive software to meet the individualistic needs of students in order for them to work at their own level of ability.

Although the individualization of instruction has not generally been significantly affected by the new information technologies in higher education, some notable exceptions do exist.

-- In two of the United States institutions of higher education, the students are able to work at their own pace in completing various course objectives on the microcomputer. In one of these universities, microcomputers are located throughout the dormitories, giving the students

a great deal of flexibility in completing course assignments.

-- In the United Kingdom case study of further education, the college operates on a philosophy to insure that every student makes use of the new technology in ways that are relevant to his or her studies and will be transferable to future changes in the workplace.

Because the distance education student is isolated in the learning environment, a degree of individualization of learning is inherent in this setting.

-- The British Columbia case study points out that distance education creates an environment of student-controlled learning. This has been liberating and intimidating aspects.

-- The Australian university case study indicates it is now more possible to individualize distance programs than produce standardized products. Students can work at their own pace under a computer-managed instructional system and can have access to a wide variety of information.

-- It is also significant to note that the Turkish case study reports no individualized instruction, in that only one video machine and program were available.

The lack of human interaction in distance education is a major change in the teaching/learning environment. However,

various new strides in technology are increasing the possibilities of some interaction even in distance education.

-- The Australian university case study describes the use of teletutorials (teleconferencing by telephone) that provide interaction between staff and students by allowing group discussions and teleconferencing via satellite.

-- The British Columbia case study documents similar advances that will help to compensate for the "missing link" in distance education.

The attitude toward technology of those involved in distance education varies with the situation.

-- The video system-aided instruction in the Turkish case study has motivated the teachers and helped them transfer their learning from one curriculum area to another. Furthermore, the success of this in-service training program has spread and created interest in teachers from other schools for the deaf. The parents have also become interested, and some attend similar training once a year.

-- The British Columbia case study indicates individual differences in the views of the learners. Some would prefer on-campus access to people and resources and less distraction at home. Others preferred the comfort and convenience of the distance setting away from the

anxiety-laden classroom. A frequent comment by the distance education students was that they worked very hard for the course credit and that the courses were academically rigorous.

-- Instructors in the British Columbia case study reported excessive amounts of time in the preparation of distance education materials, but also satisfaction in the quality of the products.

The general attitude of those in higher education toward the new information technology ranges from very positive to a more "wait and watch" stance.

-- In a New Zealand case study, most of the faculty respondents indicated staff satisfaction in terms of enthusiasm and motivation in participating in the development of new innovations. However, some of the respondents cited frustration in terms of lack of technical back-up support and access to equipment, as well as excessive amounts of time needed for preparation and providing extra assistance to students.

-- The United Kingdom study of further education states that in order for lecturers to change their attitudes towards teaching and learning, they must first recognize that a problem exists in their using traditional methods. The College is attempting to influence the

attitude of staff through the use of NIT for administration and management.

-- The faculty in the United States higher education case studies range in attitude from full commitment to the NIT to healthy skepticism. Those in the former category believe that faculty and students must have the ability to interact with the machinery of the Information age, while those in the latter category believe that the role that computers can play in instruction is highly overrated.

-- A New Zealand case study reports study attitudes ranging from increased interest, motivation, and enthusiasm to some resistance, fear, caution, and apathy. The majority were in the positive category.

Changes in Allocation of Physical Resources

All respondent US districts reported policy changes with regard to the provision and utilization of physical resources. Many districts have established or plan to establish a computer laboratory in each school building. Often space is made available from empty classrooms, with appropriate rewiring and security measures added. Some districts prefer to have the computers available in each classroom, particularly at the elementary level. In this situation, the computers are usually kept on desks designed to be easily moved. The districts in the United

States study generally could not estimate the numbers of students enrolled in the various computer science courses. As with the primary level, it is difficult to estimate the numbers of secondary students and teachers who are involved with the use of computers.

-- As reported by the US Council of the Great City Schools, the ratio of students to computers is vastly improved over the primary level, with one computer available for every 186 secondary (grades 7 to 12) students.

-- In Denmark approximately 20 percent of the primary schools (February 1984) are equipped with microcomputers. There is a ratio of one computer for every 125 pupils.

-- In Denmark every secondary school has at least eight microcomputers with a ratio of one computer for every 40 students.

-- While the United Kingdom Government schemes have been highly successful in encouraging schools to acquire microcomputers, the volume of hardware purchased is still a long way from that which would enable significant change to take place in the provision of learning opportunities. A recent survey from the DES and Schools Broadcasting Council indicates that every secondary school and a third of all primary schools now have a microcomputer but this still means that there is only

one microcomputer for every 200 pupils.

-- In the United Kingdom every secondary school has at least two microcomputers.

It is important to be aware of the consistency of policy and hardware distribution in a country with a centralized educational structure. The decentralization of the US educational system encourages inconsistency which can foster extremes of supply and quality while making it difficult to gather information.

Changes in Policy Structures

Indications of policy changes related to technology are apparent in all of the USA case studies up to the college/university level. Some governing boards have stated explicit strategies, others have indicated implicit strategies through certain administrative actions, still others are at the investigative stage of policy-making. The observed policy changes have affected four areas: (1) the instructional program, (2) physical facilities, (3) administrative staffing, and (4) financial allocations.

At the college/university level, most institutions report that formally adopted policies have not been altered by technology. However, the same institutions report changes in various practices and precedents, such as in financial allocations, instructional requirements or guidelines for computer literacy, long-range plans, and administrative staffing.

Changes in the instructional program are considered elsewhere. Policies are explicit, implicit or under consideration and development. Changes in policy relating to physical facilities follow curricular changes (see Teaching/learning Environment) as do allocation of staff and financial resources.

Policies regarding the implementation of technology in the instructional programme fall into two types: those that focus on the student and those that focus on the teacher. Some districts have addressed their policies to the curriculum and

what each student is expected to learn. Others have focused their policies on teacher training and what new competencies teachers should demonstrate. A few districts have developed plans which have integrated both these components. Many governing boards are considering or have already instituted new requirements for graduation which include a demonstration of computer literacy. The extent to which "computer literacy" is explicitly defined varies greatly from district to district. A few districts have mandated teachers to take some computer training which is arranged by the district. Some districts will not approve a school's purchase of hardware until an appropriate number of teachers have been trained. One respondent district requires that all the teachers pass a certification test to indicate knowledge of computers.

Institutions of higher education have added new courses within departments, new departments, and new degree programmes with a technological focus.

Policy changes are most evident in the area of financial allocations. The implementation of technology is expensive, and districts have utilized a wide variety of strategies to meet the costs of this endeavor. A critical point which must be noted is that even in districts which are reducing staff as a budget measure, resources are being found to purchase computer hardware and software.

A definite increase in financial allocations for NIT is noticeable in all the case studies of higher and further education. Some trends emerge:

-- The bulk of financial resources has been earmarked for hardware.

-- Several campuses have altered or plan to alter physical facilities to accommodate the increase in NITs.

-- Funds tend to be more available for course proposals that have a technological focus.

Although some of the colleges and universities report the centralization of new purchase, planning, and decision-making regarding NITs, the majority allow individual departments and/or faculty members to develop their own plans. A New Zealand case study points out that university departments and faculties have always cherished their autonomy. Unfortunately, this situation also tends to result in a measure of unnecessary duplication.

Nearly all U.S. districts have addressed the need to designate administrative staff to coordinate the technology effort in the district.

-- Most districts have hired at least one and usually more new central office administrators to plan and coordinate the implementation of technology in the instructional and/or management area of the system.

-- Two large respondent districts have established a Department of Technology. The functions of such a

department may include centralized procurement of hardware and software, evaluation of hardware and software, maintenance, teacher training, and implementation assistance to individual schools.

-- Some districts prefer to utilize all levels of staff in the planning and implementation efforts, rather than to designate specialists for one role.

-- Some small districts have added new technology-related responsibilities to the assignments of existing staff members, rather than hiring new staff.

The area of distance education is so new that no real changes in institutional structures have yet been documented to any significant level. However, certain cautions and suggestions should be noted in anticipation of rapid growth in this area.

-- Admissions policies should become more flexible with regard to distance education students. The typical student may lack certain academic qualifications, but usually compensates by increased interest and motivation.

-- Distance education can meet the needs of those people who could profit the most from further education but who cannot afford to pay the educational fees usually charged for higher education. Special education services should be provided for such groups of people

(e.g., new immigrants, the unemployed, the handicapped) through government and/or private sector subsidies.

-- Competition among universities is keen, and universities are now faced with competition from the private sector. It is important that the cost-effectiveness of delivery systems be continuously addressed, and that learning systems be developed that are not wasteful of money or resources. Distance education programmes have higher development and lower delivery costs over time than on-campus courses. Institutions with similar goals should form co-operative networking units to keep costs low and avoid duplication of effort.

-- Often educational establishments tend towards self-conservation and are often slow to adapt and respond to a changing environment. Evidence of resistance to change which is due to feelings of job insecurity is found in the case studies.

CONCLUSION

These case studies indicate that the impact of the new technologies on education, although powerful, is nonetheless inchoate and as yet undefinable. These technologies have generated a need to modify certain curricular structures--a need which has been answered by tampering with the curriculum before adjusting preparations and higher or larger structures within which the curriculum is situated. The larger ramifications of these adjustments include changes in teacher training and responsibilities, reallocation of budget and physical space and the eventual adoption of policy changes which will lend control to the adjustments that are necessitated. Larger, controlling structures have not developed outside the USA (as presented in this survey) to an extent where they can be described. The NITs are somehow having a powerful impact on education which is responding, reacting, and trying to gain control to become positive to exploit these technologies. Reassessments and reappraisals of all curricula are perhaps the most visible by-products of technology.

Another very strong attitude is evident however. Some educational commentators are questioning the degree to which the NITs will impact education pointing to the investments made in closed circuit television and in programmed instruction in the 60s and 70s, and their failure to meet expectations. They sug-

gest that the microcomputer may be just another "fad" or trend which will lose its glamour in time. This view underestimates two important characteristics of the NIT. One is the pervasive influence of information technology throughout societal and economic life and the resulting consequences for the relevancy of the content of the existing curriculum. The second is the interactive capability of the NIT, which previous audio-visual technology in schools have lacked.

The case studies demonstrate the major changes beginning to take place in the content and process of the curricula due to the introducation of information technology. It may result in the study of information technology as a subject in its own right, as an extension of existing computer studies work, or as a cross curricula activity. It influences the content of the syllabus for a specific subject to take account of changesnduced by the application of information technology in that subject area--the study of robotics in craft and technology courses is a case in point. The technology may influence the way in which a subject is taught. The use of information retrieval packages to handle census material encourages a different approach to historical analysis. This in turn emphasizes the need to introduce information handling and problem solving skills and to recognize their importance alongside basic numeracy and literacy. There is beginning to be a reappraisal of methodology, in particular the opportunities for individualized and independent forms of

study.

The sources of financial support for computers and instructional programmes reflect ingenuity and special interest groups rather than any firm commitment to optimum utilization. In too many cases, the large-scale purchase of hardware seems to have preceded any comprehensive planning of how to use it. Pressure from parents, community groups, and computer vendors may be having a larger influence on the purchase of equipment than actual needs of the students and teachers.

Lack of high quality and appropriate software is cited frequently as a stumbling block toward effective use of technology. At the present time, software tends to be directed at lower-level cognitive skills, such as drill and practice, enrichment, and remediation. Until computers address the development of higher-order reasoning skills and problem-solving, their effect will naturally be limited.

The greatest satisfaction for courseware is found in districts/schools that have developed their own to match local needs and curriculum objectives. This, however, is costly and time-consuming. Nevertheless, considering the large amounts of expenditures for hardware, a redirection of financial allocations toward software development might be more cost-effective in the long run. Production of original programs is expensive, and it is often more economical to purchase existing products.

But there is a danger of losing natural experience if too many imported programs are used. That is a key question in this area as a whole: Do we import culture when we import software?

The new information technologies do stimulate a great deal of interest and motivation, particularly at the elementary and secondary levels. Faculty in higher education appear somewhat more reserved than faculty at the lower levels, although students indicate strong interest at all levels. These studies tend to demonstrate that microcomputers have had a greater impact on the curricula of the more decentralized secondary education than on that of primary or higher education.

RECOMMENDATIONS

Training of teachers is being undertaken much more in depth by school districts than by teacher education institutions. This may cause a problem in the future when school districts have completed training of all in-service teachers and assume that new teachers have received appropriate pre-service training.

Since very little evaluation of the impact of NITs on the quality of instruction or student achievement has been conducted, attention should be directed toward this aspect before any increase in funds toward programme development. Evaluation should focus on components of technology-related instruction

that appear to be effective as well as those that appear to be unnecessary or detrimental to learning. Mechanisms for the subsequent dissemination of such information are vital.

Computer-related courses for both students and teachers lack attention to the societal implications of the NIT. Courses should include discussions of the human, ethical, political, and economic implications of the new information age.

The new information technologies have the potential to be the "great equalizer" by reaching all levels of the population and individualizing instruction appropriately. However, these case studies indicate we are very, very far from such a state. The ratio of computers to students is huge, and at present, special populations of students (e.g., gifted, disadvantaged) have the greatest access. Furthermore, the lack of good software limits the extent to which individualization of instruction can actually occur.

While new technology-related courses are being added to the curriculum at nearly all levels, little is being done to modify the existing curriculum. Since there is just so much time in the school day, attention should be given to reviewing the overall curriculum for obsolete, unnecessary, or irrelevant material that may be dropped and/or changed. At the same time, mechanisms for the development of more interdisciplinary courses should be developed.

Students have to "learn to learn" and to learn to gain access to knowledge. But as learning is a social phenomenon and as people need contact with other people in order to learn some subjects, the need for a human interface has not diminished. Humans will continue to help each other to learn, but technology in education will involve a change of thinking about education and the role of teachers. Change of thinking is the first challenge for the human interface. The new learning systems require self-learning and responsibility, and the role of the human interface is now more crucial than ever before. As more and more information is available in the home, as more people can be served without the need for attendance, the locus of learning will change in importance.

The control of the educational task is increasingly delivered into the hands of the student. The learning could become student-controlled rather than teacher-controlled. This can have a liberating effect on the learner, offering a degree of freedom and power never before experienced in the educational system; but it can also be intimidating, as one is thrown back on one's own resources.

Case study respondents disagree as to the future role of information technology in education. Some view the computer as just another learning tool, one that will be important for instruction insofar as it facilitates teaching and learning. Perhaps the most exciting possibility that information technolo-

gy holds for education is in making available more flexible opportunities for learning best suited to the individual's needs and circumstances. The new information technology will be able to help potential students find out what opportunities are available; provide new ways of delivering learning materials and in formats that allow much greater interactivity between the student and those materials; provide new ways of communication between the student, tutor, and other students; and make possible new techniques for helping students and teachers monitor progress. These opportunities are all based upon the use of information technology that will be found increasingly in the home. The information technology will support a shift of power away from the teacher towards the learner and make possible a considerable improvement in the quality of educational provision and opportunity. Others believe that the use of the computer can make true individualization of instruction a reality. Others believe that educators must now rethink the role of the teacher within a new structure of the classroom, one which fully incorporates the computer into instruction while the teacher guides and manages more than teaches. In any case, until software address the development of higher-order thinking and reasoning skills as well as the interactive nature of learning, the computer will remain just another learning tool and the teacher will remain the provider.

As new devices such as computer, television, and teleconferencing, enter to change the learning environment, so the interface between teacher and student is changed. If technological changes take place more quickly than changes in our ability to understand them, this problem will need to be addressed more fully if educators are to keep pace with our present age of rapid technological expansion. The effect of well-applied technology will be to improve instruction, but the effect of improved instruction is almost always to put greater demands on the creative teacher.

These case studies indicate that the powerful impact of the new information technologies on education is still inchoate and, therefore, undefinable. These technologies have caused a need to modify certain subject areas. The larger ramifications of these adjustments include changes in teacher training and responsibilities, allocation of budget physical space and time and, eventually, policy changes which will lend control to the adjustments that are necessitated. These larger commanding structures have not developed to an extent where they can be defined and described. NITs are somehow having an impact on education which is responding, reacting, and attempting to gain control.